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CENTRAL INTELLIGENCE AGENCY
INFORMATION REPORT

COUNTRY USSR

SUBJECT Assessment of Soviet Research on Porosity
of Sediments In Relation to Oil Structures

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SUMMARY

1. The Soviet geologist, A B Vistelius, published five papers from 1944 - 47 as a summary of an attempt to relate porosity of sediments to oil structures. The conclusions appear to show that hydrocarbons occur in areas which are more porous than those which do not contain oil.

2. It does not appear _____ to be a revolutionary discovery. If there were   25X1 a direct relationship -- and there well may be one -- then possibly a series of not less than three dry holes may or may not indicate a gradient which could be followed. Clearly, if a well hits oil, the fact that the deposits have greater porosity is interesting, but academic. To be of use, the prediction must act as a guide in geological prospecting before oil is found.

3. As a secondary series of conclusions, it may well be that porosity and thickness _____ an amount of dolomite, grain size, and color)   25X1 show a periodic oscillation in limestone-dolomite-saline rock series. It may also be possible to correlate the maxima-minima of this oscillating curve. It seems, however, an expensive procedure because it necessitates a very considerable body of data and _____ more than the one   25X1 control section required by Vistelius. We know that sediments show rhythms or cycles, but the correlations of such cycles have certainly proved more successful than that of other parameters.

4. _____ a number of intriguing   25X1 possibilities exist, but Vistelius has not established one satisfactorily. His method of approach is admirable in its mathematical rigor. His conclusions appear to be lukewarm after all the work.

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5. There is, of course, no way to check on his conclusions without his, or an equivalent amount of, raw data but his enthusiasm runs away with him in many places wher he attempts to apply his findings. The maps and sections are on too small a scale to use as a check, and the discrepancies evident from these rather poorly-reproduced diagrams make the conclusions sound unconvincing.

6. Finally, it would be very interesting to attempt to duplicate this work on sediments [   ] with our own experimental analysis [   ]

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VISTELIUS' POROSITY ANALYSIS IN BUGURUSLAN PETROLIFEROUS REGION

7. In one of Vistelius' papers, he aims to adduce the behavior of porosity coefficient in a block of Spirifer deposits (Permian limestones) from seven boreholes in the western part of Buguruslan petroliferous region. This article titled "Notes on Analytical Geology" appeared in Comptes Rendus (Doklady) de l'Academie des Sciences de l'URSS, Vol XLIV, no 1, pp 26-30, 1944.

8. All values of the porosity coefficient fit within a formula of the general type:

$$y = m + nx + e^{a_1 x + b_1} \cos(w_1 x - \varphi_1) + e^{a_2 x + b_2} \cos(w_2 x - \varphi_2)$$

y = value of porosity coefficient in %.
x = depth in meters measured from the roof of the Spirifer deposits.
m = mean value of the porosity coefficient.
n = coefficient at the linear member.
a_1, a_2 = coefficients of extinction.
b_1, b_2 = parameters characterizing the intensity.
w_1 w_2 = periods.
φ_1 φ_2 = initial phases of the process determining the value of the property investigated.

9. Vistelius' conclusions are the following:

   (a) Porosity shows a periodic variation in the vertical sections studied, and

   (b) The parameters of the equation show some relationship not to depth but to structure and possibly to presence of hydrocarbons.

10. [   ] there is nothing wrong with empirical approach, although it sounds somewhat complicated. Vistelius' results do not appear to justify the complexity of the treatment. Porosity is related to many things besides structure and, of course, porosity is related to hydrocarbons -- no holes, no oil. [   ] to be useful a proof of the empirical equation would need a very much larger amount of data than is included in this article.

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11. In another article by Vistelius, "Frequency Distribution of Porosity Coefficients and Epigenetic Processes in Spiriferous Layers in the Oil-bearing Region of Buguruslan", Compt Rend (Dokl) Acad Sci URSS, Vol 49, No 1, pp 43-46, 1945, he assumes the following:

   (a) Frequency distribution of porosity coefficients established during sedimentation is a normal (Gaussian) distribution.

   (b) The normal distribution is disturbed by epigenetic (cementation and leaching) processes, and hence the disturbance may be measured by skewness and kurtosis of the resulting frequency distribution.

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12. In data on 8 districts containing from 23 to 194 samples each, or a total of 978 samples, Vistelius finds that each district yields a value for α_1 (Vistelius skewness) and i (Vistelius kurtosis) and when these are plotted in isopleths of α_1 and i, a pattern is shown in which porosity is higher than normal in an oil district and lower in barren district. This is related to connate water diagenesis in the carbonate rocks. His conclusion is that porosity is higher in oil regions than outside.

13. Undoubtedly Vistelius' conclusion is correct, but his assumptions are not necessarily sound and the relationship of this porosity distribution to diagenesis by connate waters, while plausible, is not proved.

VISTELIUS' OSCILLATION EQUATION

14. Vistelius, in "Results of Fossilization of the Vibratory Motion of the Earth's Crust as Expressed by Means of the Series

$$\sum_{i=0}^{h} e^{a_i x + b_i} \cos(\omega_i x - \varphi_i) "$$

Compt Rend (Dokl) Acad Sci URSS Vol 49, No 7, pp 514-517, 1945, shows the following:

    (a) The oscillation of porosity over 4000 sq km fits the periodic function given above, and

    (b) The periodic oscillation is related to the thickness.

15. He deduces that the porosity and thickness periodic variations are fossilized rhythms of the sedimentation. He generalizes that primary and secondary oscillations may be differentiated by means of ω in the equation and suggests that any parameter may be used, not only porosity and thickness, in equations of this form to study rhythms of sedimentation.

16. ☐ Vistelius seems to expect a lot from one equation and, while rhythms or even cyclic sedimentation is the rule rather than the exception in sediments, the fact that this equation solves the problem is not very convincing.

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OCCURRENCE OF RHYTHMS AND THEIR CORRELATION

17. "The Rhythms of Porosity, and the Phenomenon of Phase Differentiation in Sedimentary Deposits", Compt Rend (Dokl) Vol 54, No 6, pp 515-517, 1945, is another Vistelius paper dealing with rhythms of porosity. In the case of Upper Devonian, Carboniferous, Lower Permian and part of the Upper Permian of the Volga-Uralian oil region, the rhythm of porosity is the following:

$$y = \sum_{i=0}^{k} e^{a_i x + b_i} \cos(\omega_i x - \varphi_i) \qquad k = 3$$

where y = porosity; x = depth at which porosity was determined. a, b, φ, ω, are parameters characteristic of every vertical section investigated. The parameter ω results in three groups of rhythms:

    (1) Macrorhythms   (2) Mesorhythms   (3) Microrhythms

18. He concludes, therefore, that the macrorhythms are related (correlatable) in a regional sense over the whole Volga region according to the following:

    (a) The mesorhythms are grouped in terms of districts within the region.

    (b) The microrhythms are related to local structural features.

19. Vistelius' final paper, "On the Correlation of Mesorhythms in the Lower Permian Deposits of Trans-kama Tartaria and their Stratigraphic Significance",

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Compt Rend (Dokl) Acad Sci URSS Vol 55, No 3, pp 237-240, 1947, includes the following details:

(a) By drawing sections of mesorhythms of porosity, it is stated that the mesorhythms may be correlated.

(b) Mesorhythms are independent of petrographic composition, ie, change in lithology does not affect them.

(c) Mesorhythms are independent of erosion of the deposits.

On this basis the mesorhythms may be used to correlate the sections and to show what layers are missing.

20. Porosity mesorhythms, Vistelius concludes, can be used to correlate limestone-dolomite-saline rock sections across distances of several hundreds of kilometers with the following requirements:

(1) Must have complete key sections.

(2) Must have key horizon upon which to base sections.

(3) Must use several profiles or sections.

21. The last two papers by Vistelius are based on empirical investigations which apparently indicate that (a) rhythms occur, and (b) they can be correlated regionally. There can be no challenging of the conclusions in the absence of the data upon which they are predicated. Accepting the correlations, they are still bound to suffer from the same disadvantages as any lithological correlation now in use.

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